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CHANGING PATTERN IN THE INDIAN FLORA

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INTRODUCTION

Plant wealth has been utilised by man for a variety of purpose from times immemorial. Modern man is doing this increasingly exploiting wild plants and upsetting the habitats. Often forests of single species are made where natural forests with several species existed. This upset in the natural ecosystem and change in vegetation has created a large number of other problems. In this paper only recent changes in the vegetation and flora of the country, mainly due to human activities are discussed. The various factors responsible for changing the pattern of Indian flora can mainly be discussed under deforestation, afforestation and introduction and naturalization of adventive weeds.

DEFORESTATION

Much of the Indian flora has suffered from this. Man has been clearing the original forests for agriculture, for industrialization, for human settlements and for raising artificial forests and plantations with selected economically important species such as *Eucalyptus, Tectona, Shorea* and others.

Shifting cultivation or 'jhumming' as it is popularly known in N. E. India is a primitive type of agriculture practised among some tribals, specially in the hills of North-east India. Jhumming involves the clearfelling of the forest trees and allowing them to dry and before the onset of the monsoon, the vegetation and dried trees, etc., of the entire area is burned for cultivation. After cultivating the land for 2 or 3 years and when the yield decreases the area is abandoned and these nomadic tribes select some other forested areas and repeat the process. Earlier the cycle of jhumming used to be between 25-50 years, but with the increase in population the cycle has come down to 5-8 years, with the result the forests are being cleared off at a very fast rate (Plate 1, Table 1). Today, it is a very pitiable sight in Garo Hills of Meghalaya to see the grassy hills which were once clothed by thick evergreen forests. Once the vegetation is removed, the top soil is washed down due to rains and thus the area becomes unsuitable for forests in due course of time and only secondary forests in the form of bamboo thickets occupy the place.

The secondary vegetation that comes off naturally vary in the strength and composition of floristic elements. There is a regular succession observed in these secondary formations, and even a 25-30 year old jhummed area differs considerably compared with a non-jhummed area (Table 2).

Destruction of forests for normal settled

PLATE 1 : A view of forests being cleared off.

cultivation, for raising new townships and capitals, and destruction due to creation of huge dams, etc., coupled with natural calamities such as cyclones, earthquakes, floods and other factors have altered the vegetation and flora to a great extent. Removing the original forests for monoculture is also to some extent changing the natural ecosystem. This reforestation programme is taken up by the forest department in areas where the natural forests are proved to be unproductive.

Burning : Extensive forests in the country are being destroyed annually due to forest fires. Man is again responsible for this either directly or indirectly. In the months of March and April, when the forests become very dry, a carelessly thrown match-stick or an unguarded village fire is enough to cause devastating effects on vegetation. The jhum owners never bother to protect the fire from spreading to adjoining areas.

Forest fires are of common occurrence in deciduous forests. Once the fire breaks in such forests, it continues for days together and destroy a large tract of vegetation. Such burnt areas are colonised by secondary vegetations and most of the fire resistant species invade the area. Teak (*Tectona grandis*) forest by continuous burning would in all probabilities give rise to various seral types like khair forest (*Anogeissus latifolia—Acacia catechu* association), or to dry thorn forests (*Ziziphus ruguosa—Emblica officinalis* association). Most of these stages are represented in various areas of Satpuras (Karnick, 1967). Burning is associated with a chain of changes in the soil which in turn is directly related to the vegetation it supports.

It should be noted that deforestation or 'desertification' leads to destruction of habitat for many species which may be endemic or economically important. Orchid flora which was so rich both in number of species and in number of individuals in each species in Khasi and Jaintia Hills of Meghalaya some hundred years ago when Hooker wrote his *Flora of British India,* is now considerably reduced. It is worthwhile to mention here that *Vanda coerulea* Griff. (Blue vanda) which was once so abundant in these hills represent one of the rare species of the present day orchid flora. Hooker (1854) collected 7 men's head load of this beautiful orchid to plant in Kew Gardens; whilst it is now very hard to find a dozen of these plants in these hills. Similarly *Aerides multiflorum* Roxb., *Cymbidium elegans* Lindl., *Dendrobium densiflorum* Wall., *D. nobile* Lindl., *D. formosum* Roxb., *Paphiopedilum venustum* (Wall.) Pfitz., *Pleione praecox* (Sm.) D. Don, *Coelogyne cristata* Lindl. are now becoming scarce in Meghalaya. This has been partly due to reckless exploitation by the collectors and tourists and partly due to disturbance of the natural habitat brought about by the deforestation.

In case of *Nepenthes khasiana* Hk. f. (Pitcher plant), which is endemic to Meghalaya and *Eria crassicaulis* Hk. f. endemic to Khasi hills, the situation is worse since the habitats for these species are limited and found only in some pockets. Further, because of the botanical curiosity *Nepenthes Khasiana* is being exploited by botanists and suppliers of biological materials. Similarly *Dischidia rafflesiana* Wall., *Coptis teeta* Wall., etc. have all become very rare in these regions mainly due to human activities. Unless conservation measures are taken against such endemic and rare species it is likely that we may loose these species for ever.

How many of our endemic or rare species have already fallen victims to such activities cannot be assessed in the absence of documents. Comparative studies on early floras and recent floras are necessary. Comparative studies on the flora and vegetation of some 'sacred forests' having relic vegetation which are untouched due to religious beliefs with that of adjacent areas afford us a glimpse of the richness of the original forest that must have once prevailed and is now degraded considerably due to human activities. Such sacred forests are now maintained in Mawphlong, Mowsmai and Shillong peak in Meghalaya.

Similar situation exists in the flora of Biligirirangan hills in south India. The forest in these regions have also suffered much due to deforestation activities. The flora of this interesting region has been studied by Barnes (1944); Kammathy *et al.,* (1967) and Rao (1974). A comparison of the floras given by these authors reveals a gradual decrease in the number of species. Different forest types have been described from this region starting from scrub jungles to evergreen forests. It is quite probable that the area once supported thick evergreen forests which on disturbance must have given rise to various seral types as we notice today. Huge areas today are brought under coffee cultivation. This coupled with shifting cultivation that is practised to some extent in this region has led to the depletion of the natural vegetation. Barnes (1944) has recorded 66 species of orchids of which 47 species could not be collected by the subsequent workers (Kammathy *et al.*, 1967; Rao, 1974).

Natural calamities such as floods, cyclones, earthquakes, etc., also to some extent have altered the vegetation. There are cases where the rivers have frequently changed their course altering the vegetation or completely destroying them. Partly these natural calamities are due to ecological imbalances for which man is again responsible.

AFFORESTATION

Afforestation in general, means foresting the unforested, usually barren and unproductive areas. The forest department has taken up this programme in almost all states. As a result, one can see fine plantations of *Eucalyptus, Casuarina, Prosopis*, etc., in rocky barren areas or along the sandy coastal areas as a programme of dry zone afforestation. This has greatly changed the pattern of Indian flora since the earlier barren areas are gradually converted into fine plantations of some introduced species. *Eucalyptus globulus* Labill, indigenous to Australia was introduced by Captain Cotton in the Nilgiris in the year 1843. But today there are extensive plantations of this species not only in Nilgiris but also in various other parts of the country. In Gujarat state alone 63,000 have been planted with *Casuarina equisetifolia* Forst. f. and *Prosopis julifera* DC. along the sandy coastal strip of the saline arid zones and in desert borders.

Similarly, at higher altitudes (1800-2200 m) exotic *Cryptomeria japonica* (from Japan) and *Pinus patula* (from Mexico) are extensively planted. Fine plantations of these can be noticed near Darjeeling and Kalimpong areas of West Bengal. Likewise *Pinus kesiya* plantations from the conspicuous flora in Khasi and Jaintia hills of Meghalaya (Plate 2). Tables 3 and 4 give the extent of areas brought under afforestation programme in different states or regions. These man-made forests have altered the flora and landscape to such an extent that they now seem to be original forests of the country existing quite sometime past.

PLATE 2 : *Pinus kesiya* plantations from the conspicuous flora in Khasi and Jaintia hills of Meghalaya.

INTRODUCTION AND NATURALIZATION OF FOREIGN WEEDS

The introduction and naturalization of foreign weeds on Indian soil has greatly influenced the pattern of Indian flora. For a long time it was believed that the Indian flora is an admixture of floras from adjacent countries (Hooker, 1904; Champion & Trevor, 1938), though India has got a flora of her own (Chatterjee, 1940). By this it is very clear that there has been an inpush of a large number of plants from the neighbouring countries. Many of these have become adventive in nature and have altered the floristic composition of many areas (Maheshwari, 1960). These species following their immigration have become more or less wild and now seem to be permanent denizens of the native flora. Distribution of these obnoxious weeds has always a strong effect on the native flora, since many of these weeds have replaced much of the indigenous species, probably because of their strong allelopathic effects.

Tremendous amount of literature has poured in on the introduced weeds of various regions in the country during the last few decades (Prain, 1903; Bruhl, 1908; Calder, 1919; Kashyap, 1922; Biswas, 1934; Raizada, 1939, 1950; Sandwith, 1946; Sengupta, 1949; Sunder Raj, 1956; Srivastava, 1956, 1964; Maheshwari, 1960, 1961; Maheshwari & Pal, 1975; Mathew, 1969; Ramaswamy et al., 1973; Rao & Suryanarayana, 1978). Various factors are responsible for the naturalization of these foreign weeds (Maheshwari, 1960), the discussion of which is not in the perview of the present paper and nor it is possible too in an article like this. Man is greatly responsible for the introduction and subsequent spread of these weeds, although migratory birds in some cases are responsible. It is worth mentioning here that the Bird Sanctuary at Ranganthittu island in Mysore is visited by Burmese migratory birds and consequently there has been a report of a Burmese species *Lindernia mollugnoides* (Benth.) Wettst., which is fairly common today (Bhaskar & Razi, 1975).

A few important weeds which are adventive in nature and have altered the general vegetation of the country are discussed below. It should be kept in mind that many of these alterations in flora and vegetation are of only local importance.

Ageratum conyzoides Linn. : This is a south American species that has spread fairly common throughout the country. The species is seen in profusion along the forest margins, water coarses and along the bunds of paddy fields and forms a striking feature of vegetation when in bloom.

Lagascea mollis Cav. : This is a native of Mexico, introduced between 1824-1845 around Calcutta Botanic Garden. Now the species is fairly common in the plains of Tamilnadu (Gamble, 1915-1936) and Karnataka (Rao, 1974).

Tridax procumbens Linn. : This is again a native of Mexico, probably introduced as an ornamental plant (Ridley, 1930). Today this has replaced much of the native elements on old Fort walls, grasslands and in similar habitats.

Alternanthera pungens H.B. & K. : This species is native to Tropical America, and is recorded for the first time in 1908. Subsequent to its introduction, it has spread fairly widely in open fallows and roadsides and has become a nuisance owing to its spinecent bracts which also help in easy dissemination the species.

Croton bonplandianum Baill. : It is a native of Paraguay and introduced into Chittagong by ballast by about 1897 (Ridley, 1930). Till recently this was fairly common along roadsides and waste places in Karnataka, which to some extent is now being replaced by another adventive weed, *Parthenium hysterophorus* L., *Croton bonplandianum* has also become a dominant element of vegetation in many areas of Assam plains (Rao, 1974).

Mikania micrantha H. B. & K. : This species must have been introduced into the lower elevations of Arunachal Pradesh from Tropical America, probably during world war II, and has now spread over vast areas choking other vegetation and forming a troublesome weed (Rao, 1974). In plains of Assam this species covers the forest canopy and has become a menace to foresters. The species is also very common in south India, specially in plantations.

Eupatorium : Two species of this genus have become very adventive in India. *E. odoratum* Linn. is very abundant in lower altitudes while *E. adenophorum* Spr. is quite dominant on higher elevations. These species have got naturalized by about 1920 and today perhaps no other weed is so adventive and conspicuous as these two species, specially in the north-east region of India. *E. odoratum* forms extensive patches in Kerala and Mysore and in some forests forms the *only* undergrowth replacing all other species including *Lantana camara* L. (Rao, 1974).

Acanthospermum hispidum DC. : This plant is a native of south America, reported to have spread to south India with ballast. Gamble (1915-36) reports this species from south Canara and Salem districts. But today this has formed a conspicuous element in the flora of most of the districts of Karnataka and other states of south India. Rao (1974) also reports this species from Tenga valley of Arunachal Pradesh.

Crossocephalum crepidioides (Benth.) S. Moore : This tropical African species entered India in the thirties of the present century (Srivastava, 1964). Today this has become completely naturalized in the flora of north-eastern region and also south India, and has replaced many of our native elements.

Parthenium hysterophorus Linn. : This species is fairly a recent introduction to India (Rao, 1957). Being introduced from Tropical America, this has spread like wild fire in many parts of the country (Ladwa & Patil, 1961; Hakoo, 1963; Maheshwari, 1966; Vaid & Naithani, 1970; Ramaswamy *et al.* 1972; Rao, 1978). This species is quite dominant in south Indian plains. This weed had not established in Bangalore by the time Flora of Bangalore was written (Ramaswamy & Razi, 1974); but today all around Bangalore this is the only dominant weed. Recently this species is also reported from north-eastern region (Rao, 1978). Evidently this weed has replaced much of our native species.

Eichhornia crassipes (Mart.) Solms. : This aquatic weed forms a striking feature of hydrophytic vegetation in the country. Being introduced as an aquatic ornamental, this has become a great nuisance today, and has totally eliminated other hydrophytic species from the ponds wherever this species occurs. This free-floating species has tremendous capacity for vegetative multiplication and covers the entire pond in a very short period.

The above is just a passing reference to only a few important adventive weeds which have partly masked the native vegetation and flora of the country. Vast areas covered by these weeds were earlier clothed by some native weeds. However, we do not have any record or evidence to show how many of our native species have been eliminated. It is worthwhile to keep this in mind by flora writers and monographers, who instead of just basing their conclusions on earlier collections deposited in some herbaria, should also try to record the 'deletions' in the flora. The damage caused by these foreign weeds can be appreciated only when such informations are made available.

Table 1 : Shifting cultivation in N. E. region of India

State	Total area affected by shifting cultivation '000 ha	Area under cultivation at one time '000 ha	Tribal families involved '000 nos.
Arunachal Pradesh	248.58	92.00	148
Assam			
a. Mikir Hills	415.10	54.00	45
b. N. Cachar hills	83.20	25.60	13
Manipur	100.00	60.00	50
Meghalaya	416.00	76.00	68
Mizoram	604.13	61.60	45
Nagaland	608.00	73.54	80
Tripura	220.80	22.30	43
Total :	2695.80	445.05	492

Source : Anonymous 1976. Report of the National Commission on Agriculture part IX. Forestry (Controller of Publications, Delhi).

Table 2 : Important species composition in different age groups of jhums in Meghalaya

1 year	7 years	15 years	50 years	Non jhummed forests
Imperata cylindrica	*Eupatorium odoratum*	*Dendrocalamus* spp.	*Gmelina arborea*	*Canarium resiniferum*
Eupatorium odoratum	*Carex* spp.	*Ficus hispida*	*Shorea robusta*	*Tetrameles nudiflora*
E. adenophorum	*Lagerstroemia parviflora*	*Litsaea* spp.	*Castonopsis indica*	*Mesua ferrea*
Desmodium spp.	*Terminalia bellirica*	*Butea monosperma*	*Garcinia cowa*	*Toona ciliata*
Setaria glauca	*Callicarpa macrophylla*	*Combretum* sp.	*Vitex peduncularis*	*Terminalia chebula*
Panicum repens	*Kydia calycina*	*Machillus* spp.	*Artocarpus chaplasha*	*Artocarpus chaplasha*
P. khasianum	*Emblica officinalis*	*Sterculia* spp.	*Eugenia communis*	*Ficus rumphii*
Commelina spp.	*Bauhinia variegata*	*Ardisia solanacea*	*Prunus* spp.	*Machillus khasiana*
Dioscorea spp.	*B. purpurea*	*Vitex peduncularis*	*Sterculia* spp.	*Kayea assamica*
Golinsoga parviflora	*Dillenia* spp.	*Dillenia* spp.	*Duabanga grandiflora*	*Milliusa roxburghiana*
Smilax zeylanica	*Wrightia tomentosa*	*Gmelina arborea*	*Gmelina arborea*	

This table lists only a few very commonly occurring species in different age groups.

Table 3 : Afforestation in various States in India
(Area in hectares)

	Kerala	Tamilnadu	Karnataku	Goa, Daman & Diu	Madhya Pradesh	Uttar Pradesh	Gujarat	Andaman
Genera								
Eucalyptus	23530	18,297	1,4527	4,860	37,000	6,760	—	—
Casuarina	—	4,507	—	234	—	—	6,300	—
Tectona	—	7,630	—	3,535	42,000	1,930	—	5,536
Prosopis	—	—	—	—	—	—	23,500	—
Anacardium	—	31,733	—	2,488	—	—	—	—
Pinus	230	—	—	—	—	—	—	—

Data gathered from Symposium on man-made forests in India (1972), and deals with only some important species tried in these states.

Table 4 : Extent of man-made forests in India created up to 1968-69
('000 hectares)

Species	N. E. region	Western & central	Southern & S. eastern	Northern
Teak	22.6	65.9	179.9	17.1
Sal	9.0	—	—	20.0
Sisso	—	—	—	47.2
Conifers	2.8	—	—	24.0
Eucalyptus	12.2	85.2	118.9	67.7
Bamboos	—	9.3	13.4	47.2
Casuarina	—	4.0	25.3	—
Cashew nut	—	6.8	67.0	—
Babul	—	—	—	37.0
Khair	—	5.2	30.8	—
Miscellaneous	125.4	63.4	104.0	155.1

Source : S. D. Thapar (1975) *India's Forest Resources*, Macmillan Co. Delhi.

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